OBSERVATIONS ON THE CRUSTACEAN FAUNA OF THE REGION ABOUT MAMMOTH CAVE, KENTUCKY.

By William Perry Hay,
Howard University, Washington City.

During the month of August, 1901, the writer spent a week at the Mammoth Cave of Kentucky and, through the courtesy of Mr. H. C. Ganter, the manager of the estate, was able to make fairly complete collections of the invertebrates, both within the cave and in various neighboring springs and streams. As the object of the visit was to obtain extensive series of the crustaceans of the region, and to record observations on their habits, very little attention was paid to other groups, and aside from the crustaceans the collections were very meager. A few specimens of an earthworm resembling *Lumbricus*, a quantity of fresh-water sponge taken from the rocks well within the exit of Echo River, and one or two specimens of *Cottus* sp. (*richardsonii ?*) taken in Roaring River are the only ones worthy of note.

As is well known, the Mammoth Cave of Kentucky has been the subject of many articles long and short, or volumes, which have appeared from time to time. Its fauna has been studied more carefully and by more naturalists than that of any other American cavern, as numerous lists and papers will testify.

The localities given in the present paper are often those within the cave, but the name by which the particular spot is known is usually given for the sake of accuracy. Richardson's Spring is a small pool of clear water supplied by a very small trickling stream and is about 1 mile from the entrance. Roaring River, a passage which is never visited except by the collector, is reached by a low and very muddy and difficult passage which turns off from the main route a short distance beyond Echo River. The mouth of the passage is said to be 2 miles from the entrance of the cave. At times of high water the entire passage, as well as contiguous portions of the main cave, are flooded, but usually the water is confined to a series of small pools among the rocks and mud of the floor of the passage and the stream at the end. Roaring River itself is a stream some 15 or 20 feet wide, and an average depth of 1 foot. It flows with a steady current and is known to be a part of Echo River.

All the specimens upon which this paper is based have been deposited in the United States National Museum.

Suborder AMPHIPODA.

Family GAMMARIDÆ.

GAMMARUS PROPINQUUS, new species.

Type.—No. 25545, U.S.N.M. Collected by W. P. Hay, August 28, 1901, from a spring about 2 miles north of Mammoth Cave, Kentucky.

Description.—Similar to *Gammarus fasciatus* Say, but with the following characters:

First pair of antennæ less than half as long as the body, the flagellum with about twenty-five segments, the accessory branch much shorter than either segment of the peduncle and composed of but two or three segments.

Second antennæ from half to three-fourths as long as the first; the second and third basal segments of about equal length; the flagellum slightly longer than either segment and composed of twelve articles.

First pair of gnathopoda with the inferior margin of the carpus and hand rather densely fringed with hairs, the longest of which are equal to the width of the carpus; hand with the palmar surface very oblique, hardly distinguished from the inferior surface, armed with a few long bristles and short teeth; dactyl much curved.

Second pair of gnathopoda larger, stronger, the palmar surface less oblique, being at an angle of about 50 degrees with the inferior surface; carpus and hand fringed with hairs as in the preceding appendage; dactyl stronger and straight.

Basal segments of the last three pairs of pereiopoda lamellar as usual, but with the posterior margin entire and almost unarmed; the succeeding segments more or less armed with hairs and short spines, but nowhere excessively.

Eye elongate, reniform.

Fifth and sixth abdominal segments with median and lateral groups of spines on their posterior margins. Seventh segment with a few scattered spines, apparently not arranged in groups, along the posterior margin.

Telson cleft to its base; each division with the distal extremity armed with a tranverse row of slender spines; outer margin with two rather slender spines.

Remarks.—This species, which appears to be distinct from any hitherto described, was found in small numbers in several localities in the region about Mammoth Cave. The best specimens were obtained from the type locality and a few good ones were taken at the outlet of Echo River. In color they were a purplish gray. They were hiding under flat rocks in the cold spring water.

CRANGONYX VITREUS Cope.

This species was observed in considerable numbers in Mammoth Cave, both in its type locality, Richardson's Spring, and in the Roaring River district in small pools. When undisturbed it was most often seen resting quietly or walking slowly through the mud on the bottom with the body vertical and half buried in the soft ooze of the surface. As a result of these movements there were innumerable trails running in all directions, but never of a great length, as if the animal, tiring of walking through the mud, had decided to swim to some more remunerative feeding ground. When once disturbed they swam rapidly about, either on their sides or with the back uppermost, or sought safety by lying quietly behind some projecting pebble or mass of earth. It was observed that when concealing themselves they usually lay on one side. Owing to their exceedingly smooth covering and small size they were very difficult to catch.

Suborder ISOPODA.

Family ASELLIDÆ.

MANCASELLUS MACRURUS Harger.

This species was observed in two or three localities. A few specimens were taken in a spring some 2 miles northeast of the hotel. They seemed to be all very small and immature, but on careful examination several of them could be seen carrying eggs.

At the so-called mouths of Echo River, a series of three large springs at the foot of the hill in which the entrance to Mammoth Cave is found, *M. macrurus* was collected in abundance. They were of rather small size but decidedly larger than the specimens taken from the spring mentioned above.

They were usually found clinging to the under side of flat rocks, which lay in shallow water, and until a large number was disturbed by turning over rocks I was not able to observe any of them crawling about. They were living at this place in company with about equal numbers of *Asellus stygius* (Packard). The association seemed indiscriminate, for I could not see that either species was partial to any particular location or condition in the spring.

CÆCIDOTEA STYGIA Packard.

This well-known species was taken in considerable numbers from a small stream in one of the upper levels of Mammoth Cave and was found in smaller numbers in small pools in other parts of the cavern.

It was also found in abundance at the mouth of Echo River, where it was living in company with *M. macrurus* Harger. They were usually found clinging to the stone walls of the pool in which they were living or could be seen slowly walking over the bottom. When disturbed their movements were considerably quickened, but they were unable to move with any great rapidity. If when disturbed they were clinging to the sides of their pool their first effort to escape was by letting go and falling to the bottom; in case the pool was deep this method was quite effectual. When removed from the water they seemed almost absolutely helpless, the weak legs being quite inadequate to the task of dragging along the heavy body.

Suborder MACRURA.

Family ATYIDÆ.

PALÆMONIAS GANTERI Hay.

Type.—No. 27000, U.S.N.M.

A most unexpected find in the Roaring River passage at Mammoth Cave was a small eyeless shrimp, which proves to be a representative of a family hitherto unrecorded from the North American continent.

The discovery was made one morning when I had gone alone into this passage with the intention of collecting as perfect a series as possible of the blind crayfish. A number of large *C. pellucidus* had been secured, and I was endeavoring to find others of smaller size. To this end the bottoms and the water of the clear pools were being examined most carefully. While thus engaged, an object which seemed to be a very small eyeless fish, appeared swimming slowly along near the surface. From the way it moved in attempting to escape capture it became evident that it could not be a fish, and a determined effort was made to secure it. After a most exasperating chase, during which my specimen seemed more than once to have eluded me, it was captured, and I saw immediately that another animal had been added to the fauna of the cave. I then set about finding others, and, knowing what to look for, they were found quite easily. When first seen they were usually resting quietly or were slowly walking on the bottom of the pool, and were as insensible to the glare of my lantern as were the crayfish. They were so transparent that several times they were detected only by their shadows, and even when moving near the surface they were almost invisible. When disturbed they at once left the bottom, and by the rapid strokes of their subabdominal appendages came to the surface, where they remained for some time before sinking again to the bottom. All their movements were unmistakably shrimp-like and very different from those of any of the other crustaceans in the cave. They were very easily captured, either in the net or by gently slipping my hand beneath them as they swam slowly on the surface; in fact, the latter method was used in nearly every case. Twelve specimens were put with a live eyeless fish into a 3-ounce bottle, tightly corked, and without a change of water carried about in the cave for over four hours; on reaching the hotel most of them were still alive, and the few that were dead seemed to have been killed by the slime from the fish. Five of them lived for over two days in a tumbler of water on the table in my room, where the temperature stood at times as high as 85 degrees.

On reaching Washington a specimen was at once stained, dissected, and mounted, and I found that my shrimp was not only a new species but must stand as a representative of a new genus, to which the name *Palæmonias* was given,[1] with the specific name of *ganteri* in honor of the manager of the cave, Mr. H. C. Ganter, who afforded me the facilities for making my collection.

As the description mentioned was quite brief and unaccompanied by figures and regarded as only a preliminary notice, it seems advisable to introduce here a more detailed account of the characters of this somewhat remarkable species.

The carapace is very thin, delicate, and transparent, in form cylindrical or slightly compressed; the greatest depth is near the posterior end; the anterior border, below the eye, is produced into two spiniform points, the upper of which is the larger; the rostrum is slender and slightly wider near the middle than at the base, the lower margin bears from one to three minute teeth, while on the upper margin there are about thirteen, of which the first two or three are at the very base, almost on the carapace, and are separated by quite an interval from a group of eight or nine near the middle of the rostrum, which in turn are separated by a second small interval from the group near the distal extremity.

The abdomen is compressed, rounded above, and exceeds the cephalothorax in length. The sixth segment is as long as the fourth and fifth combined. The swimmeretts of the first segments are large and thickly fringed with setæ.

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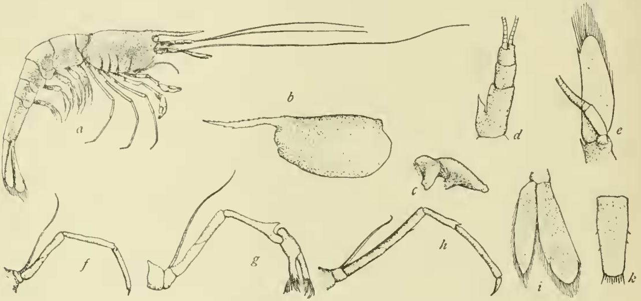
[1] Proc. Biol. Soc. Washington, XIV, pp. 179–180, Sept. 25, 1901.

PALÆMONIAS, new genus.

Similar to Palæmonetes in form and in the absence of a mandibular palpus. Gills four and a rudiment on each side. Rostrum long, slender, and serrate above and below. Antero-lateral margin of carapace with two spines. First two pairs of ambulatory appendages subequal in size and similar in form, chelate and with large bunches of pectinate bristles on the tips of the fingers. The articulation of the hand with the carpal segment is at a point on the lower surface of the hand some distance from the proximal end, and the prominent knob-like extremity fits when the limb is fully extended, into a broad sinus formed by the margin of a plate-like expansion of the carpus.

The telson is elongate, slightly angulate and bispinose on the outer margin. The extremity is arcuate and bears nine or ten slender spines. The outer blades of the tail fin are narrow and densely fringed with fine hairs; the external one is indistinctly divided near the distal end by a sinuous transverse line, at the outer end of which there is a small spine and at the inner a projecting angle.

The eyestalks are rudimentary, but seem to be considerably more prominent than in such an analogous a form as *Cambarus pellucidus*. They are quite short when compared with the rostrum, but are not hidden by it. The distal extremity is without a trace of pigment or of facets and is bluntly conical.



PALÆMONIAS GANTERI HAY.

a Right lateral view of type specimen.
b Left lateral view of carapace.
c Mandible.
d Basal segments of first antenna.
e Basal segments of second antenna.
f Third maxilliped.
g Second chelate thoracic appendage.
h Fifth thoracic appendage.
i Appendage of sixth abdominal appendage.
k Telson.

The antennules are biflagellate, the flagellæ being of nearly equal length and about as long as the antennæ. The basal segment of the antennule is expanded somewhat so as to present toward the median line a nearly horizontal blade, which at about its middle is extended into a large, strong spine directed in the same line as the remainder of the appendage.

The antennæ are longer than the body, exceeding it by about half its length; they are very slender; the scale is nearly as long as the rostrum, its outer margin concave and terminating in a small spine some distance from the rounded extremity; the second basal segment bears on its outer distal angle a minute slender spine.

The third maxillipeds are pediform and in all but size quite similar to the third, fourth, and fifth walking legs. All these appendages of the thorax bear a filiform exopidite, which is usually at least as long as the combined lengths of the four basal segments of the appendages.

The first and second pairs of pereiopods are so nearly equal in size that it is with great doubt that I venture the statement that the second pair is the larger. They are probably slightly longer but more slender. The proximal half of the limb presents no unusual characters, but the distal half has the characters peculiar to the Atyidæ. The proximal end of the carpus is slender and subcylindrical, but toward the distal end on the superior surface there appears a thin plate or ridge which gradually increases in height to a point just short of the distal end of the segment. Here it is abruptly excavated so as to present a broad sinus for the reception of the knob-like extremity of the hand. Below this sinus the carpus extends forward a short distance so as to articulate with the ventral surface of the hand and not its proximal end. The hand is subcylindrical, the postarticular portion is rounded, and, as stated above, is intended to fit closely into the sinus in the carpal expansion. The fingers are so curved as to meet only at their tips. They are apparently quite cylindrical and unarmed except at their tips, where they bear each a dense pencil of rather long, stiff, plumose or pectinate hairs. The hands and carpal segments are usually directed downward and backward so as to bring the ventral finger to the lower side, and the degree of motion between the hand and the carpus seems to be very great.

The dactyls of the last three pairs of pereiopods are minutely serrate, as are the distal extremities of the antepenultimate segment.

The gills seem to be only four in number, on each side attached to the first four pereiopods, but there may be a rudiment on the fifth.

Twelve specimens were secured, varying in length from 14 to 23 mm. from the tips of the rostrum to the end of the telson. In life they were colorless, but in alcohol they are milk white.

When I first described this genus and species I was of the opinion that its affinities were with the Palæmonidæ and the genus *Palæmonetes*, and the name *Palæmonias* was given to call attention to the fact. I had noticed the striking resemblance of the hand and carpal segment of the first two pairs of pereiopods to the similar parts of certain of the Atyidæ, but did not consider this a character of sufficient weight to overbalance the striking resemblance to certain of the Palæmonidæ in every other character. I have recently received a letter from Dr. A. E. Ortman, of Princeton University, calling my attention to other characters, and, furthermore, I have been able to secure the description of *Troglocaris schmidti* Dormitzer,[1] and have thereby been forced to reverse my opinion.

Palæmonias should certainly be placed in the family Atyidæ, and is a very close relative of the genus *Xiphocaris*, from which it seems to differ by only one character, namely, the pronounced excavation of the carpal segments. I would not be willing to accept as a good generic character that of rudimentary eyes, as has been done in this family for the genus *Troglocaris*.

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[1] Lotos, 3d year, 1853, p. 85, pl. III, fig. 1–5.

The figure of *Olophorus americanus* Saussure,[1] however, shows a rather deep excavation of the carpal segments, and if Dr. Ortman is correct[2] in regarding this the same as *Xiphocaris elongata*, the differences between *Palæmonias* and *Xiphocaris* are very slight indeed.

This species is of especial interest, since it has been shown by Dr. Ortman that the Atyidæ are extremely archaic fresh-water crustaceans, and that of them the genus *Xiphocaris* is the most primitive. In former times the distribution of *Xiphocaris* was probably far more extensive than it is at the present. To-day but three surviving species are known to science, "one from the fresh waters of the West Indies, another from streams and pools in Indo-Malaysia, and a third from the streams of New Zealand."[3] The isolated species, *Palæmonias ganteri* and *Trogolocaris schmidti*, which, as has been pointed out, may prove to be congeneric with *Xiphocaris*, are species which have been left behind in the limestone caverns when the main body of their relatives was swept to the south.

It offers also another proof of the fact that we may look to the limestone caverns of the world for many of the most valuable clues to the relationships of our present surface fauna. There are doubtless many cases in which the extension of habitat to the subterranean retreats has been quite recent; but, in the main, cave-inhabiting animals are of archaic types and date from a time when conditions were more uniform, and consequently faunal differentiations were less marked than at the present day. In support of this statement it will be sufficient to mention the occurrence in Carniola of a subterranean species of crayfish very similar to those occurring to-day in North America, and quite different from those of Europe, and the more recent discovery in Texas of *Typhlomolge*, a genus of blind, cave-inhabiting salamanders, which, so far as it is known, finds its nearest relatives in *Proteus* of Carniola.

Family ASTACIDÆ.

CAMBARUS PELLUCIDUS (Tellkampf).

The "blind crayfish of Mammoth Cave," which is now known to inhabit the subterranean water courses of a considerable portion of Kentucky and Indiana, was collected and observed frequently wherever conditions were favorable. The shallow margins of the "River Styx" and the small pools in the passage to Roaring River afforded me abundant opportunities to study this interesting species. It was no uncommon thing to have several under observation at one time.

When first observed they were usually on the bottom, resting quietly with their legs and antennæ fully extended. Unless they were disturbed they would remain in this position for several minutes, and then with no apparent reason start off at a rapid gait, move to another spot, and take up the same position. While thus resting, the only movement observable was a slight waving to and fro of the antennæ. Sometimes an individual was seen on a submerged rock mass resting in the same way; such individuals appeared to have no difficulty in running rapidly over the rough surfaces. When alarmed in any way, the crayfish would begin to show signs of uneasiness by moving slightly about in various directions, and then dart away, propelled by the vigorous strokes of its tail fin. There seemed to be no ability on the part of the animal to select a safe haven of refuge from a distance, for the flight for safety was apt to end anywhere; the course was usually laid for deeper water, but if a rock or the wall of the pool was encountered the crayfish would quickly conceal itself in a crevice and retreat beyond reach of danger. Several individuals, when repeatedly chased across a small pool, became either too exhausted or too enraged to retreat and showed a readiness to fight by rising high on the front walking legs and waving their chelæ about in the direction of the danger. Their movements were very quick, probably more rapid than those of outside species, and it was difficult to touch their antennæ and escape a nip from their chelæ.

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[1] Mem. Soc. Phys. Hist. Nat. Genève, XIV, Pt. 2, 1858, p. 472, pl. IV, fig. 31.

[2] Proc. Acad. Nat. Sci. Phila., 1894, p. 400.

[3] Idem, p. 400.

Several specimens were obtained from places where the pools were nearly or quite dried up, and it was observed that in such places the crayfish had dug for itself a hole or had crawled under a stone and was making preparations to remain. They were already in a semidormant condition and in a few days would doubtless have died. The tracks of a cave rat, several excavations made by him, and the remains of a crayfish showed that even in the fastnesses of their subterranean home the crayfishes have enemies to which they sometimes fall victims.

It has frequently been stated that disturbing the surface of the water is sufficient to frighten the crayfish. I did not find this to be the case unless the disturbance was great enough to affect not only the surface but the depths of the pool as well. Indeed I have often passed my hand completely around an individual, all ready and alert, and have brought my fingers within half an inch of its body without causing it to show further alarm. The instant it was actually touched either on its long, waving antennæ or on any portion of its body it would dart away.

From all the evidence which could be gathered it seems that in this creature the senses of sight and hearing have entirely disappeared.

At the time of these investigations the interesting article by Prentiss[1] on the otocysts of the crustacea was unknown to me and I was not led to repeat his experiments on the blind crayfish. So far as I am able to determine without careful microscopic examination the otocyst of

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[1] C. W. Prentiss. The Octocyst of Decapod Crustacea; Its Structure, Development, and Functions. Bull. Mus. Comp. Zoöl., XXXVI, No. 7. July, 1901.

C. pellucidus is perfectly normal, but it can not be claimed that it is a functional organ of hearing. The powers of equilibration in *C. pellucidus* are in no way inferior to those of the terranean species with well-developed eyes. It seems to me that the removal of the otocysts in such a blind species and the careful study of the animal's powers thereafter would give a basis for very definite conclusions as to their functions.

In a series of twenty specimens collected in the Roaring River passage ten were females, five were males of Form I, and five were males of Form II. One of the males of Form I is quite soft, and I therefore infer that ecdysis occurs in this species at about the same season as in surface-inhabiting species and that copulation takes place early in the fall. Eggs are said to be laid during the winter, but the guides were rather indefinite as to the exact time.

The smallest specimen collected, a female, is 21 mm. in length; it, as well as the next larger one (26 mm.), differs from the adults in having but one lateral thoracic spine. In a specimen 41 mm. in length all the spines above and in front of the lateral spine are developed. In a specimen 36 mm. long, from Echo River, one accessory spine is present just above the lateral spines, and a few minute granules on the sides of the head, in front of the cervical groove, indicate the patch of spines which is to be found in the adult.

CAMBARUS BARTONI TENEBROSUS, new subspecies.

Type.—No. 22346, U.S.N.M. Mammoth Cave, Kentucky. R. E. Call.

Distribution.—Known only from the type locality.

Description.—Compared with the typical *C. bartoni* from the neighborhood of Philadelphia, the carapace is less depressed and with more parallel sides, the areola is longer, the cephalic portion of the carapace is more robust, and the sides of the rostrum are more convergent. The antennæ are slender and in length exceed the body. The eyes are reduced in size and the spine armature is much more strongly developed. There is always a small but acute spine on the side of the carapace just behind the cervical groove; the two spines on the upper surface of the distal end of the meros are usually well developed, and the median internal spine of the carpus is large and strong. In addition to these there usually are, in small individuals, well-developed spines at the anterior end of the postorbital ridge and an acute branchiostegian spine. Throughout the entire series examined there is great uniformity in these characters and they contrast nicely with another small series collected from small surface streams in the neighborhood of the cave. In these the antennæ are shorter than the body; the lateral spine of the carapace, even in small individuals, is reduced to a very weak and slender point; the spines on the upper distal portion of the meros are obsolete, and the eyes are normally developed.

The individuals from the cave range in length from 108 mm. to 35 mm., while those from the surface range from 60 mm. to 10 mm.

Remarks.—This form of *C. bartoni*, which appears to be well marked, was found in considerable abundance in Echo River and the River Styx. Ten specimens were collected; one male, Form II, and nine females, two of which carried eggs. In addition to these I have examined a number of specimens from the same localities collected by Dr. R. E. Call and others.

The fact of the existence of crayfish with eyes in Mammoth Cave in company with the eyeless *C. pellucidus* has frequently been mentioned by writers on the cave and its fauna but the eyed species has always been regarded as a transient or accidental form. It has even been supposed[1] that the eyed and eyeless species interbreed so that "the blind form is continually reinforced by new blood from outside the cave." Dr. Walter Faxon, in speaking of this theory,[2] gives a number of reasons for discarding it, but later in a paragraph on *C. pellucidus testi* Hay, which in its appearance is much more like *C. bartoni* than is *C. pellucidus*, he seems to think that after all such a thing might be possible.[3]

During the course of some carcinological work the writer had occasion to review the variations of *C. bartoni* and spent over a month in the examination of several hundred specimens and considerable additional data. The trip to Mammoth Cave was made largely for the purpose of studying the relationship of the cave-inhabiting individuals to individuals living on the surface.

As is well known *Cambarus bartoni* Fabricius is a species with a very extensive range and therefore is subject to much variation. Its habits throughout the range are, so far as I know, practically uniform unless conditions are such as to preclude the possibility of following the customary mode of living. It is a frequenter of cool streams where it lives under the flat rocks or in holes which it excavates among the pebbles. It is rarely found in warm streams or ponds, and when it does occur in such situations is extremely apt to show that this unusual habitat has had effect on its structural character. In its effort to secure its favorite conditions of water, temperature, etc., it is led to ascend the streams, and although this ascent is doubtless made slowly and the attempts at ascent are often stopped or seriously checked by extensive rapids or heavy floods, it is nevertheless almost a certainty that through this habit the animal has gone to the very headwaters of many a mountain stream and in favorable seasons has crossed the divide and reached the source of some other streams. As in Virginia, West Virginia, Kentucky, Tennessee, and Indiana many of the small streams have their sources in cave streams it is easy to understand that *C. bartoni* is of common occurrence in the caverns of the region. I have observed and collected the species in several caves in Indiana and Kentucky in company with *C. pellucidus* and have found it abundant in several caves in Virginia and West Virginia where *C. pellucidus* is unknown. In one of the latter caves I collected an albinistic specimen which is quite indistinguishable from others from the same locality now that the alcohol has bleached them, and I have seen similar specimens in localities where there were no caves.

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[1] Shaler, Mem. Bost. Soc. Nat. Hist., II, 1875, pp. 362, 363.

[2] Mem. Mus. Comp. Zool., X, No. 4, 1885, p. 41.

[3] Proc. U. S. Nat. Mus., XX, 1898, p. 647.

A review of the characters peculiar to *C. bartoni tenebrosus*, for by that name the cave-dwelling form may be distinguished, shows that there is a tendency in them to approach the characteristics of *C. pellucidus.* At first thought it seems as if this might be due to interbreeding, but there are some difficulties in the way of such an explanation. In the first place the species exist in the Mammoth Cave in nearly equal number, and the females of both have been collected while in the egg-bearing state. The ova of *C. bartoni* are large, those of *C. pellucidus* are small, and no variation in the size of the eggs such as would probably result from crossing has been observed. The females of *C. bartoni*, and the males as well, will average much larger than *C. pellucidus* and are reported by the guides to kill and eat the blind species, a habit that, to say the least, would hardly be conducive to extensive crossing of the two species. *Cambarus bartoni* and *C. pellucidus* are perfectly distinct species and could, without much straining of facts, be regarded as generically distinct. The greatest differences are found in the structure of the sexual organs, and in a group which exhibits such marked specific variation in these organs it seems extremely probable that there is a reason for such differences, and that between species so unlike interbreeding would be extremely difficult if not impossible. There are known in the United States three other species of blind cave-inhabiting crayfishes and, while they undoubtedly have acquired their characters independently, they all resemble *C. pellucidus* quite closely. Slenderness of body and appendages, and length of antennæ are as characteristic of them as is the loss of eyes and color. They are conditions brought about by their environment. *C. pellucidus* alone is characterized by excessive spininess, which evidently is either a condition inherited from its ancestors or one which has been developed in response to the peculiar conditions obtaining within its habitat. It will be seen, therefore, that *C. bartoni tenebrosus* resembles all the blind species in the reduction in size of the eyes, and the increase in size of the antennæ, and the form of the body, moreover there is indication (as shown by its spininess) of its having responded to the peculiar conditions of Mammoth Cave just as *C. pellucidus* has.

These conditions point to the conclusions: First, that *C. bartoni tenebrosus* is a permanent resident of Mammoth Cave; second, that it has lived there long enough to have diverged markedly from its relations on the surface; third, that it has been affected not only by the general spelæan conditions, but those peculiar special conditions of Mammoth Cave; fourth, that it is not the ancestral type from which *C. pellucidus* has sprung; fifth, that the two species are probably to a great degree inimical to each other, and, sixth, that the idea that the two species interbreed is an erroneous one.

That specimens have been taken, as I was told at the cave, which were quite white but otherwise like *C. bartoni tenebrosus*, I do not doubt, but I regard such individuals as albinos.

Regarding the relationship of *C. pellucidus testi* Hay, I will say that so far as is known this subspecies is found in a very small area in Indiana at the very northern limits of the range of *C. pellucidus*. *C. bartoni* occurs in the same cave, but it does not resemble the blind species in any way, and has not even characters by which we can mark it as a permanent resident. Were the conditions reversed and *C. bartoni tenebrosus* found anywhere in company with *C. pellucidus testi* there might be some grounds for regarding them both as possible intermediates between *C. pellucidus* and *C. bartoni*, but under conditions as they exist such a view is untenable.

The surface inhabiting individuals of *C. bartoni* from the neighborhood of Mammoth Cave are plainly the stock from which the cave-inhabiting individuals have descended. In proportions of the body, outline, etc., they agree with the cave variety and differ very markedly from the varieties of *C. bartoni* found in Indiana and Tennessee.

CAMBARUS DIOGENES Girard.

In a collection received from Mr. Edward Hawkins, one of the guides at the cave, there were eight specimens of this species, including females and males of both forms. They agree in shape of rostrum and form of chelipeds with specimens from Indiana, the former having thickened and quite strongly converging margins; the chelæ are short and broad and the movable finger is rather deeply excavated at the base.

CAMBARUS PROPINQUUS Girard.

A few small specimens which appear to belong to this species were obtained from pools and shallow channels along Green River.

CAMBARUS RUSTICUS Girard.

A large number of small individuals of this species were collected in Green River between Mammoth Cave and Ganters Cave. Almost all the males were in the second form. They differ from the typical *C. rusticus* slightly in the greater development of spines, those of the postorbital ridges and sides of the carapace, as well as the lateral spines of the rostrum, being strong and prominent, the branchiostegian spine is small but quite evident, and the tip of the rostrum is not upturned. In one male (Form I) the anterior segment of the telson is trispinose on each side. The excessive spininess is doubtless due to the immaturity of the specimens.

CAMBARUS PUTNAMI Faxon.

This species was found in abundance in the shallow side channels of Green River in company with *C. rusticus.* Only second-form males and females were collected. In the series quite a variation in the form of the rostrum is observable; the margins in some cases being rather strongly convergent, in others nearly parallel. In almost every case the chelæ of the male have the fingers slightly gaping at the base.